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Image-based test method for vision module photoelectric performance

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1 Scope

This document describes the basic principles, testing conditions, instruments, testing samples, testing steps, data processing, testing reports of the image-based test method for vision module photoelectric performance.

This document applies to digital vision modules with linear photoelectric response characteristics, analog vision modules with digital frame grabbers, image sensors that are part of a vision module.

Note: Vision modules include monochrome, color, area scan, line scan types, etc.

2 Normative references

The contents of the following documents constitute essential provisions of this document through normative references in the text. Among them, for dated references, only the version corresponding to the date applies to this document; for undated references, the latest version (including all amendments) is applicable to this document.

GB/T 2900.56-2008 Electrotechnical terminology - Control technology

GB/T 29298-2012 Digital still camera general specification

3 Terms and definitions

The terms and definitions, which are defined in GB/T 2900.56-2008 and GB/T 29298-2012, as well as the following terms and definitions, apply to this document.

3.1 Vision module A device, that performs photoelectric conversion for the visual image with light as a carrier, finally outputs digital image data.

Note: Vision modules are generally composed of complementary metal oxide semiconductor (CMOS) or charge coupled device (CCD) image sensors and auxiliary electronic devices, which have linear photoelectric response characteristics, that is, the the light source shall be selected, as the maximum response wavelength of the tested sample;

b) When the sample to be tested is a color vision module, light sources with different wavelengths shall be selected, where each wavelength is close to the maximum response wavelength of the different color channels of the sample to be tested.

Instruments and equipment, such as light sources, irradiance meters, thermometers, incubators, shall be regularly calibrated, to ensure the accuracy of data.

7 Samples under testing During the testing process, the parameter settings of the vision module under testing meet the following requirements:

a) Temperature: The temperature of the vision module under testing shall be kept stable, during the testing process;

b) Digital resolution: The pixel bit depth of the vision module under testing shall be set to the maximum value, to reduce the influence of quantization noise in the test;

c) Gain: Set the gain of the vision module under testing, so that the saturation value of each pixel reaches the full well and the signal does not overflow;

d) Offset: Set the offset of the vision module under test, so that the number of pixels with cut-off (gray level is zero value) in the dark signal, which is output by the vision module under testing, is less than 0.5%;

e) Number of collected lines: A single image of the line array sensor vision module shall not

be less than 100 rows; the calculation formula of the area array sensor is used, to evaluate the parameters;

f) Radiation exposure: The radiation exposure of the tested sample is controlled, by the following three methods:

1) Change of exposure time under constant illumination: The brightness of the light source is fixed; the radiation exposure shall be changed, by adjusting the exposure time of the tested sample;

2) Illumination change under constant exposure time: The exposure time of the tested sample is fixed; the radiation exposure shall be changed, by adjusting the brightness of the light source;

3) Using pulse illumination under constant exposure time: The exposure time of the sample to be tested is fixed; the radiation exposure shall be changed, by adjusting the pulse width of the LED light source. The selected exposure time record the ambient temperature; record the radiation exposure conditions.

c) Follow the steps below for image acquisition:

1) The vision module under test starts to collect images. Turn on the light source.

Increases the radiation exposure, at equal intervals from 0, until the output of the tested sample is saturated. At this time, the average gray level of the collected images will not increase. It shall collect at least 10 sets of images with different radiation exposure levels;

2) Collect two brightfield images, under each radiation exposure condition.

Record the irradiance E, which is measured by the irradiance meter;

3) Turn off the light source. Collect two dark-field images without illumination, corresponding to the exposure time of each radiation exposure;

4) Turn off the light source. Collect two dark-field images without illumination, at the shortest exposure time, that can be set for the sample to be tested.

d) Calculate the responsivity, total system gain, quantum efficiency, time-domain dark noise, absolute sensitivity threshold, saturation capacity, dynamic range, signal-to-noise ratio, linearity, according to the calculation method of basic optoelectronic parameters in 9.1.

8.3 Testing of spatial non-uniformity Carry out testing as follows.

a) Power on all instruments and equipment in the testing environment.

b) Set up the sample to be tested, according to the requirements of Chapter 7. Record the ambient temperature.

c) Follow the steps below, for image acquisition:

1) The measured vision module starts to collect images. Turn on the light source.

Adjust the radiation exposure, to make the output image of the tested sample reach 50% of the saturated gray level. At this time, the average gray level of the collected image is half of the average gray level of the saturated output.

Collect L (L >= 16) brightfield images. Record the irradiance E, which is measured by the irradiance meter;

2) Turn off the light source. Keep the exposure time of the tested sample in step 1) unchanged. Turn off the light source. Collect L dark field images without illumination.

d) Calculate the spatial non-uniformity, according to the calculation method in 9.2.

8.4 Testing of dark current characteristics

8.4.1 Testing of dark current Carry out testing, as follows:

a) Power on all instruments and equipment in the testing environment. Turn off the light source. Place the tested sample in a dark field environment;

b) The sample to be tested shall be preheated to a stable state, with a constant temperature, that is, the sample to be tested shall reach a state of thermal equilibrium;

c) The vision module to be tested starts to collect images. Within the interval from the minimum exposure to the maximum exposure of the tested sample, select at least 6 exposure times, at equal intervals. Collect 2 images at each exposure time;

d) Calculate the dark current, according to the calculation method in 9.3.1.

8.4.2 Testing of temperature dependence of dark current Carry out testing, as follows:

a) Within the working temperature range of the sample to be tested, select at least 6 temperature points evenly spaced;

b) Collect images at each temperature point, according to the steps in 8.4.1; calculate the dark current at each temperature point.

8.5 Testing of spectral sensitivity Carry out testing, as follows:

a) Power on all instruments and equipment in the testing environment;

b) Set up the sample to be tested, according to the requirements of Chapter 7. Record the ambient temperature;

c) Select a wavelength-tunable light source, according to the requirements in Chapter 6. Select multiple test points, within the full wavelength range, that the tested sample can respond to. The wavelength interval, between two adjacent test points, shall be less than or equal to two times the full width at half maximum value of the light source, at the corresponding wavelengths;